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Vital Signs Monitoring of Wolf (*Canis lupus*) Distribution and Abundance in Denali National Park and Preserve, Central Alaska Network

2011 Report

Natural Data Series NPS/CAKN/NRDS—2011/204

ON THE COVER
A yearling wolf from the Grant Creek Pack walks near the Denali Park Road.
NPS photograph by Tom Meier

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This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Executive Summary

Wolves have been monitored with the use of radio collars in Denali National Park and Preserve since 1986. This work was conducted by the National Park Service (NPS) from 1986 to 1994, by the U. S. Geological Survey (USGS) from 1995 to 2002, and again by NPS from 2003 to 2011. A total of 162 wolves have been captured since NPS resumed wolf monitoring efforts in 2003. Between February 2010 and March 2011, 24 wolves were captured and radio collared in or near the Park and Preserve.

Each year, 10 to 15 wolf packs are monitored in or adjacent to the Park and Preserve. A total of 42 different wolves have worn GPS collars which determine the animal's location with an onboard GPS system and upload the data through the ARGOS satellite system. Of 97 collared wolves that died between 2003 and 2011, 40 were killed by humans and 57 by natural causes, suggesting an increase in human-caused mortality in recent years. The estimate of wolf density in March 2011 was 4.0 wolves per 1000 square kilometers, slightly higher than the density a year earlier but still lower than the long-term average of 5.4 wolves per 1000 square kilometers.

The elimination of the Stampede and Nenana Canyon Closed Areas, which formerly protected wolves in certain areas adjacent to Denali, along with the presence of intensive management and predator control programs adjacent to the Park and Preserve, has prompted concerns about impacts to the natural and healthy status of Denali's wolf populations, and impacts to visitor opportunities for viewing wolves in the Park. A new study, conducted by Bridget Borg of the University of Alaska and the National Park Service, will use specially designed GPS collars to study the movements of wolves living adjacent to the park road, and will analyze wolf movements and wolf mortality patterns to address these questions.

Acknowledgments

John Burch and Bridget Borg (NPS) captured wolves and provided suggestions for data analysis. Helicopter pilots Rick Swisher (Quicksilver Air) and Troy Cambier (Chena River Aviation), and fixed-wing pilots Dennis Miller (Caribou Air), Sandy Hamilton (Arctic Air Alaska), and Colin Milone (National Park Service) piloted aircraft on wolf capture and radio-tracking flights. Melanie Cook of the National Park Service, Dr. Sandy Talbot of the U. S. Geological Survey, and Dr. Robert Wayne of the University of California, Los Angeles, performed genetic analysis of wolf specimens. Dr. Edward DeBevec of the University of Alaska, Fairbanks, developed an online tool for decoding and managing wolf location data obtained from GPS/ARGOS telemetry collars. Telonics, Inc. (Mesa, AZ) developed radio collar designs to address unique problems of monitoring wolves in Alaska. Dr. Kimberlee Beckman of the Alaska Department of Fish and Game performed wolf necropsies and arranged for immunological testing of wolf blood specimens. The Washington Animal Disease Diagnostic Laboratory performed immunological testing of wolf specimens. Jane Bryant, Denise Albert, N. J. Gates, Tyler Danielson, Bridget Borg, and Melissa Snover served as observers during wolf capture operations. Philip Hooge, John Burch and Maggie MacCluskie (NPS) reviewed this manuscript and provided additions and corrections.

Introduction

This report summarizes efforts to monitor wolves (*Canis lupus*) in Denali National Park and Preserve (DENA), Alaska, through spring 2011. Wolves occur in all three parks of the Central Alaska Monitoring Network (CAKN): Denali National Park and Preserve, Yukon-Charley Rivers National Preserve, and Wrangell-St. Elias National Park and Preserve. Wolves are one of six keystone large mammal species in interior Alaska, along with grizzly bears (*Ursus arctos*), black bears (*Ursus americanus*), moose (*Alces alces*). caribou (*Rangifer tarandus*), and Dall's sheep (*Ovis dalli*). Wolves are of great importance to people from both consumptive and non-consumptive viewpoints, and to the ecosystem as a whole. As a top predator, wolves may play a key role in influencing ungulate populations, and as a result may influence vegetation patterns (Miller et al. 2001, Ripple and Beschta 2003). The effects of wolves on ungulate populations (Mech and Peterson 2003) may be important determinants of ungulate availability for subsistence harvest on NPS Park and Preserve lands in Alaska, and harvest by the general public on NPS Preserve lands (National Park Service 2003). Data obtained from wolf monitoring are used to assist with wolf den site protection and other aspects of the Denali Wolf-Human Conflict Management Plan (National Park Service 2007).

Wolves are a species specifically identified in the enabling legislation and management objectives of all three CAKN parks (U. S. Congress 1980). Wolves are of great importance to park visitors because of the unique opportunities to view wolves in Alaskan parks. While the primary objective of monitoring is to track the distribution and abundance of wolves, a variety of additional data is obtained in the monitoring process. This information is likely to have great value for wildlife management and research. The body of data on wolf populations in Alaska parks is of great value in developing scientific models of predator/prey systems. In heavily visited portions of the parks, managers want to know the locations of active wolf dens and rendezvous sites (pup rearing areas) so that they can be protected from disturbance. When intensive wolf harvest or wolf control take place near parks, it is vital to know the patterns of travel of park packs, in order to determine whether they are being significantly impacted by activities outside of the parks. Data on the genetic, morphological, and immunological characteristics of wolves, obtained in the course of wolf capture, will be important in evaluating long-term changes in wolf populations in Alaska.

Parkwide monitoring of wolves in Denali National Park and Preserve was initiated by Resource Management Ranger John Dalle-Molle in 1986, with principal investigators L. David Mech and Layne Adams. Field work between 1986 and 1994 was performed by John Burch and Tom Meier. From 1995 through 2002, Layne Adams, now with USGS, conducted wolf monitoring efforts. Since 2003, John Burch and Tom Meier have again conducted the field work.

Measurable Objectives

- Locate non-radiocollared wolf packs using Park and Preserve lands by snow tracking.
- Capture and radio-collar 1-3 individuals in each wolf pack identified in the study area.
- Determine the demography (numbers, colors, age structure) of monitored wolf packs.
- Obtain morphological measurements from captured wolves.

- Obtain genotypic data (mitochondrial and microsatellite DNA) from captured wolves.
- Obtain immunological (disease exposure) data from captured wolves.
- Determine pack size for each collared pack in fall (early winter) and spring (late winter).
- Define the mosaic of wolf home ranges (population area) for estimating wolf densities.
- Perform annual capture efforts to maintain coverage of radio collars in the population.
- Detect pack extinction and pack formation events in the population.
- Detect changes in wolf density over time.
- Detect changes in wolf pack sizes over time.
- Detect changes in wolf home ranges over time.
- Detect changes in the morphological, immunological, and genetic makeup of the wolf population over time.
- Investigate the effects of wildlife management activities on the natural and healthy character of wolves in Denali.
- Investigate the biological and social characteristics of wolf viewing by visitors in Denali, and factors that may affect wolf viewing opportunities.

Methods and Materials

Methods of wolf monitoring used in DENA followed the Wolf Monitoring Protocol for Denali National Park and Preserve, Yukon-Charley Rivers National Preserve and Wrangell-St. Elias National Park and Preserve, Alaska (Meier et al. 2009). An exception to this is the determination of wolf pack territories (Figures 1-7). Wolf pack territories were not rigorously calculated using the 95% of locations that would produce the smallest home range. An appropriate protocol (e.g. harmonic mean removal of dispersed points) must be developed in order to automate this task. The present wolf pack territories were produced by manually removing selected wolf locations that were thought by the author to represent extraterritorial forays or pre-dispersal movements by the collared animals.

Results and Discussion

Captures and Radio Telemetry

Five wolves from 4 packs were captured and radio-collared in winter 2009-2010, and 19 wolves from 9 packs were captured in winter 2010-2011 (Table 4). The Iron Creek Pack, occupying the mountain slope in the west end of the park, was first collared in February 2010. One new pair of wolves (The Alder Creek Pair) was discovered when an adult male wolf from the East Fork Pack paired with a wolf of unknown origin, but the male wolf was trapped and killed on the Toklat River shortly afterward. GPS-collared wolves from the Bearpaw and Somber Packs dispersed west to the North Fork and South Fork of the Kuskokwim River, respectively, and established packs there. The years 2010 and 2011 saw the extinction of several wolf packs that had previously been followed, including the Toklat Springs, Totek Hills, Chitsia, and Mount Margaret Packs in the northeastern part of the study area, and the Otter Lake and Tonzona Packs to the west. Collared wolves from the Kantishna River and Somber Packs began travelling together in winter 2010-2011, and these two packs appear to have merged.

Morphological data, including sex, weight, age and color, and blood and tissue samples for genetics and disease analysis, were gathered from captured wolves. Morphologic data is presented in Table 4. Genetics results are being analyzed by biologists at the United States Geological Survey Alaska Science Center (USGS) and University of California Los Angeles (UCLA). Wolves living in or near Denali have been occasionally been found to be infested with the dog louse *Trichodectes canis* and also with another coat abnormality of unknown origin (Beckmen et al. 2009, Wolstad et al. 2009). Immunological surveys of wolves in interior Alaska have revealed exposure to a number of diseases but have not detected evidence of serious population effects of disease (Mech et al. 1998, Zarnke and Ballard 1987). One disease that has the potential to seriously affect wolf pup survival is Canine Parvovirus (CPV). Immunological studies of Denali wolves have revealed a rate of exposure to CPV as high as 50% in some years, among wolves that were captured and blood sampled (R. Zarnke, pers. comm.).

Between May 1, 2009 and April 30, 2011, collared wolves were located approximately twice per month by aircraft. A total of 49 different radio-collared wolves from 23 packs were monitored for some or all of this period, resulting in 1,477 locations of collared wolves. In addition, 3,709 locations were obtained from 20 wolves that wore GPS/ARGOS collars for some or all of this period. The Telonics GPS collars used on most of these wolves obtain one location each day and store the location coordinates within the collar. The data is uploaded weekly through the ARGOS satellite system, and also remains stored within the collar so that all data can be uploaded when the collar is retrieved. In March 2011, six specially designed GPS collars were placed on wolves that live near the park road; two each from the East Fork, Grant Creek, and McKinley Slough Pack. Designed to provide more detailed data on the movements of these packs, the collars determine each wolf's location every 3 hours. The road study GPS collars are equipped with breakaway devices and will fall from the wolves in September 2012. Further information on this study can be found below. Since 2003, more than 15,900 wolf locations have been obtained from GPS/ARGOS collars. Since 1986, more than 15,600 wolf locations have been obtained by conventional radio telemetry. The locations of all collared wolves in this study's 25-year history are plotted in Figure 8 in the Appendix.

Wolf Pack Sizes and Density Estimates

Aircraft surveys in spring 2011 observed 71 wolves, 21 of them radio-collared. These wolves were found in 10 packs covering an area of 117,994 square kilometers, mostly within the boundaries of Denali National Park and Preserve north of the Alaska Range (Figure 7 and Table 3, in Appendix). This produced a density estimate of 3.94 wolves per 1000 square kilometers, a slight increase from the spring 2010 count of 59 wolves in 12 packs and density of 3.46 wolves per 1000 square kilometers. Wolf densities for the past 3 years have been the lowest in Denali since 1987 (Table 1 and 2, Figures 8 and 9). No obvious explanation for this low density is apparent, and wolf numbers may have begun to rebound.

The present method of determining wolf density involves the use of minimum convex polygons to estimate individual wolf pack territories, and combining a number of territories into a larger, non-convex polygon representing the population. In implementing this method, subjective decisions are by made NPS wildlife biologists to exclude forays by wolf packs outside of their usual range, so that the population area is not inflated by the inclusion of areas that are actually

occupied by other, uncollared wolf packs. CAKN personnel are developing methods using kernel estimators (White and Garrott 1990) that might provide a more objective estimate of pack territory sizes and wolf densities (J. Burch and J. Schmidt, pers. comm). Dispersing or lone wolves were not included in population size or density estimates.

Mortality

Sixteen radio-collared wolves died between 1 May 2009 and 30 April 2011. Seven were legally shot, trapped or snared outside of the Park/Preserve. Nine died of natural causes. Table 4 (see Appendix) summarizes the fates of wolves captured and radio-collared between March 2003 and March 2011. Of 87 radio-collared wolves that were captured during this period and subsequently died, at least 34 (39%) were killed by humans. Two of those were trapped within Park/Preserve boundaries by qualified subsistence users, and the remainder were killed outside of Park/Preserve boundaries. The data suggest an increase in human-caused mortality in the Denali wolf population. During the period 1986-1994, only 8 (14%) of 58 mortalities of radio-collared wolves were human-caused (Mech et al. 1998).

Beginning in 2000, the State of Alaska established the Stampede Closed area to protect wolves west of the Savage River (Figure 11) from harvest, in order to preserve wolf viewing opportunities in Denali National Park. In 2003, the Nenana Canyon Closed Area, a narrow strip of land east of the George Parks Highway, was created for the same purpose. In March 2010, the Alaska Board of Game voted to eliminate both of these closed areas. No radio-collared wolves were killed by humans during winter 2010-2011, in these areas newly opened to wolf harvest.

Intraspecific strife (the killing of wolves by members of neighboring wolf packs) probably remains the leading cause of wolf mortality in DENA (Mech et al. 1998), but many carcasses are consumed or decomposed before they can be investigated, so that only 39% of natural mortality between 2003 and 2011 was documented as wolf-caused, while most mortalities were classified as of unknown natural cause. It is likely that many of these mortalities were also wolf-caused.

Plans for the Coming Year

In 2011-2012, we plan to maintain contact with approximately 10-12 wolf packs inside or partly inside Denali National Park and Preserve. Collars will be maintained on 2 members of each pack if possible, with additional collars on the East Fork, Grant Creek, and McKinley Slough Packs as part of a two-year study of wolf movements, wolf viewing, and wolf mortality by University of Alaska Fairbanks graduate student and park employee Bridget Borg. Monitoring efforts will continue, with wolves being located about twice per month, with extra monitoring flights in spring and fall to document pack sizes and pup production.

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Appendix A Tables and Figures

Tables

Figures

Table 1. Early-winter (fall) density of wolves, Denali National Park and Preserve, 1986-2010.

YEAR	NUMBER OF PACKS MONITORED	TOTAL WOLVES IN PACKS MONITORED	COMBINED AREA OF MONITORED PACKS (KM^2)	ESTIMATED DENSITY: WOLVES / 1000 KM^2	POPULATION ESTIMATE INSIDE THE PARK*
1986	4	22	8,180	2.7	46
1987	9	70	13,150	5.3	92
1988	14	121	14,670	8.2	142
1989	11	127	15,240	8.3	144
1990	11	136	13,930	9.8	169
1991	13	137	14,275	9.6	166
1992	15	120	13,620	8.8	152
1993	12	93	9,900	9.4	162
1994	12	72	11,145	6.5	112
1995	11	80	12,045	6.6	115
1996	11	104	12,776	8.1	141
1997	12	75	12,808	5.9	101
1998	12	68	12,578	5.4	93
1999	15	80	12,699	6.3	109
2000	18	112	14,554	7.7	133
2001	18	91	13,802	6.6	114
2002	14	86	12,226	7.0	121
2003	11	84	11,682	7.2	124
2004	14	78	14,630	5.3	92
2005	15	106	15,367	6.9	119
2006	17	111	17,439	6.4	110
2007	20	147	17,757	8.3	143
2008	14	86	16,607	5.2	89
2009	15	89	17,061	5.2	90
2010	11	88	17,994	4.9	84

* wolf estimate = the calculated wolf density projected across an estimated 17,270 square km of potential habitat within park boundaries, north of the Alaska Range

Table 2. Late-winter (spring) density of wolves, Denali National Park and Preserve, 1986-2011.

YEAR	NUMBER OF PACKS MONITORED	TOTAL WOLVES IN PACKS MONITORED	COMBINED AREA OF MONITORED PACKS (KM^2)	ESTIMATED DENSITY: WOLVES / 1000 KM^2	POPULATION ESTIMATE INSIDE THE PARK
1986	4	26	7,380	3.5	61
1987	8	37	12,125	3.1	53
1988	14	69	15,355	4.5	78
1989	13	98	16,810	5.8	101
1990	10	106	13,930	7.6	131
1991	13	111	14,275	7.8	134
1992	15	103	13,620	7.6	131
1993	12	68	9,900	6.9	119
1994	10	61	11,145	5.5	95
1995	12	59	12,120	4.9	84
1996	11	69	12,640	5.5	94
1997	11	78	13,080	6.0	103
1998	12	61	13,121	4.6	80
1999	13	69	12,699	5.4	94
2000	17	71	14,378	4.9	85
2001	16	87	13,802	6.3	109
2002	15	73	13,026	5.6	97
2003	18	75	11,682	6.4	111
2004	14	78	16,061	4.9	84
2005	15	66	14,630	4.5	78
2006	15	103	15,367	6.7	116
2007	16	93	17,439	5.3	92
2008	20	99	17,757	5.6	96
2009	16	65	16,607	3.9	68
2010	12	59	17,061	3.5	60
2011	10	71	17,994	3.9	68

* wolf estimate = the calculated wolf density projected across an estimated 17,270 square km of potential habitat within park boundaries, north of the Alaska Range

Table 3. Wolf pack sizes, Denali National Park and Preserve, 2007-2011.

PACK	2007		2008		2009		2010		2011
	spring	fall	spring	fall	spring	fall	spring	fall	spring
ALDER CREEK									1
BEARPAW	8	10	9	5	5	2	2	6	5
BOOT LAKE		1	(2)	2	4	3	(3)	(8)	(9)
CASTLE ROCKS	5	7	7	2	0				
CHITSIA	9	11	5	7	1	0			
EAST FORK	15	15	11	16	11	12	5	11	6
GRANT CREEK	5	5	3	6	6	14	11	16	16
HAUKE	4	4	3	0					
HOT SLOUGH	2	7	7	8	6	7	5	3	4
IRON CREEK					2	6	5	9	7
KANTISHNA RIVER	1	1	2	5	2	6	6	8	0
MCKINLEY RIVER	5	10	2	0					
MCKINLEY SLOUGH	8	15	15	14	11	15	14	19	18
MCLEOD 2	4	6	2	0					
MOOSE CREEK					2	2	2	0	
MT MARGARET	6	7	3	2	2	5	0	0	
NENANA RIVER					2	6	2	5	4
OTTER LAKE					2	2	2	3	0
PINTO	3	10	4	0					
SAVAGE		2	2	6	0				
SOMBER	6	11	8	8	4	2	2	6	7
STARR LAKE	3	6	4	3	3	6	3	3	3
TOKLAT SPRINGS	6	9	6	(5)	(1)	(3)	(3)	(3)	0
TONZONA		(1)	(2)	2	2	1	0	0	
TOTEK HILLS		6	6	(4)	(3)	0	0	0	0
TURTLE HILL	3	4	0						
TOTAL WOLVES	93	147	99	86	65	89	59	89	71
AREA IN KM^2	17,439	17,757	17,757	16,607	16,607	17,061	17,061	17,994	17,994
WOLVES/1000 KM^2	5.33	8.28	5.58	5.18	3.91	5.22	3.46	4.95	3.95
EST WOLVES IN PARK*	92	143	96	89	68	90	60	85	68

* wolf estimate = the calculated wolf density projected across an estimated 17,270 square km of potential habitat within park boundaries, north of the Alaska Range

Peripheral packs, with sizes in parentheses, were not included in the density estimate that year.

Table 4. Wolf captures, Denali National Park and Preserve, 2003-2011.

WOLF	DATE	RECAP	SEX	AGE	COLOR	PACK	STATUS / FATE
0087	03/16/03	Yes	F	Adult ~8	Dark Gray	Kantishna River	Recaptured, recollared
0316	03/16/03	No	M	Adult ~4	Gray	Castle Rocks 2	Killed by wolves
9755	03/16/03	Yes	F	Adult ~6	Light Gray	Pinto	Shot west of Healy
9974	03/16/03	Yes	M	Adult ~2	Dark Gray	Death Valley	Died, unknown natural causes
0092	03/17/03	Yes	F	Adult ~5	Gray	Mount Margaret	Killed by wolves
0317	03/17/03	No	F	Adult ~3	Black	Castle Rocks 2	Snared near Lake Minchumina
0079	03/18/03	Yes	M	Adult ~6	Blue	Muddy River	Died, unknown natural causes
0089	03/18/03	Yes	M	Adult ~6	Gray	McKinley Slough	Missing
0104	10/26/03	Yes	M	Adult ~4	Gray	Mount Margaret	Snared west of Healy
0318	10/26/03	No	F	Adult ~4	Gray	East Fork	Snared west of Healy
0103	10/27/03	Yes	F	Adult ~4	Gray	Grant Creek	Collar failed
0319	10/27/03	No	M	Adult ~2	Gray	Death Valley	Trapped west of Healy
0320	10/28/03	No	F	Yearling	Gray	McKinley Slough	Missing
0321	10/28/03	No	F	Adult ~4	Gray	Straightaway	Starved
0322	10/28/03	No	F	Yearling	Black	Kantishna River	Missing
0401	02/18/04	No	F	Yearling	Gray	Muddy River	Shot west of Healy
0402	02/18/04	No	F	Adult ~5	Blue	Chitsia	Recaptured, recollared
0403	03/06/04	No	F	Adult ~4	Gray	Turtle Hill	Collar failed
0102	03/07/04	Yes	F	Adult ~6	Light Gray	100 Mile	Died, probably starved
0404	03/07/04	No	M	Adult ~5	Light Gray	100 Mile	Starved
0405	03/07/04	No	F	Yearling	Gray	100 Mile	Died of unknown causes
0406	03/07/04	No	F	Adult ~5	Gray	Herron	Collar chewed off
0407	03/07/04	No	M	Adult ~2	Gray	Herron	Collar chewed off
0408	03/08/04	No	F	Yearling	Gray	Mount Margaret	Recaptured, recollared
0409	03/08/04	No	F	Adult ~4	White	Toklat Springs	Recaptured, recollared
0410	03/08/04	No	M	Yearling	Gray	Toklat Springs	Shot on lower Toklat River
0411	03/08/04	No	F	Yearling	Gray	Chitsia	Recaptured, recollared
0412	03/08/04	No	F	Adult ~4	Gray	McKinley River	Died, unknown natural causes
0413	03/08/04	No	M	Pup	Gray	Castle Rocks 2	Died, unknown natural causes
0087	03/09/04	Yes	F	Adult ~9	Blue	Kantishna River	Starved
0414	03/09/04	No	M	Adult ~4	Black	Bearpaw	Recaptured, recollared
0415	03/09/04	No	F	Adult ~3	Gray	Bearpaw	Recaptured, recollared
0416	03/09/04	No	F	Pup	Gray	Starr Lake	Missing
0411	03/04/05	Yes	F	Adult ~2	Gray	Chitsia	Collar failed
0414	03/04/05	Yes	M	Adult ~5	Black	Bearpaw	Recaptured, recollared
0501	03/04/05	No	M	Adult ~3	Gray	Mount Margaret	Recaptured, recollared
0502	03/04/05	No	F	Yearling	Gray	Mount Margaret	Died, unknown natural causes
0503	03/04/05	No	M	Adult ~2	Gray	Chitsia	Recaptured, recollared
0504	03/04/05	No	M	Adult ~8	White	Toklat Springs	Shot on lower Toklat River
0505	03/05/05	No	M	Adult ~3	Gray	McKinley River	Recaptured, recollared
0101	03/06/05	Yes	F	Adult ~6	Gray	Kantishna River	Killed by wolves
0107	03/06/05	Yes	F	Adult ~6	Gray	McKinley Slough	Killed by wolves
0506	03/06/05	No	M	Adult ~3	Black	Lone (Hult Creek)	Starved
0507	03/06/05	No	M	Adult ~3	Black	Kantishna River	Killed by wolves
0508	03/07/05	No	F	Adult ~4	Gray	Turtle Hill	Killed by wolves

Table 4. (Continued). Wolf captures, Denali National Park and Preserve, 2003-2011.

WOLF	DATE	RECAP	SEX	AGE	COLOR	PACK	STATUS / FATE
0408	02/01/06	Yes	F	Adult ~3	Gray	Mount Margaret	Died from blunt trauma
0601	02/01/06	No	M	Adult ~2	Black	Turtle Hill	Trapped west of Healy
0403	02/08/06	Yes	F	Adult ~6	Light Gray	Turtle Hill	Recaptured, recollared
0602	02/09/06	No	F	Yearling	Gray	Toklat Springs	Shot on lower Teklanika River
0605	02/23/06	No	F	Pup	Black	East Fork	Shot near Cantwell
0606	02/23/06	No	M	Adult ~3	Gray	Pinto	Died of unknown causes
0607	02/23/06	No	F	Adult ~5	Gray	Pinto	Shot west of Healy
0103	02/24/06	Yes	F	Adult ~6	Gray	Grant Creek	Killed by wolves
0215	02/24/06	Yes	M	Adult ~6	Gray	Grant Creek	Killed by wolves
0214	02/28/06	Yes	F	Adult ~7	Blue	McKinley River	Killed by wolves
0505	02/28/06	Yes	M	Adult ~4	Gray	McKinley River	Recaptured, recollared
0608	02/28/06	No	F	Adult ~4	Silver	Starr Lake	Drowned
0609	02/28/06	No	F	Adult ~3	Black	Starr Lake	Recaptured, recollared
0610	03/01/06	No	F	Adult ~4	Gray	Somber	Recaptured, recollared
0611	03/01/06	No	F	Yearling	Gray	Somber-Tonzona	Still being monitored
0612	03/01/06	No	F	Adult ~4	Gray	Castle Rocks 3	Recaptured, recollared
0613	03/01/06	No	M	Adult ~3	Blond	Castle Rocks 3	Missing
0614	03/01/06	No	M	Yearling	Gray	Toklat Springs	Trapped south of Healy
0615	03/11/06	No	M	Adult ~7	White	Straightaway	Killed by wolves
0616	04/17/06	No	M	Pup	Gray	Kantishna River	Trapped in Minto area
0617	04/17/06	No	M	Pup	Black	Kantishna River	Recaptured, recollared
0618	04/17/06	No	F	Adult ~2	Gray	East Fork	Recaptured, recollared
0503	12/11/06	Yes	M	Adult ~4	Gray	Chitsia	Recaptured, recollared
0620	12/11/06	No	F	Yearling	Gray	Chitsia	Trapped north of park boundary
0621	12/11/06	No	F	Yearling	Gray	Toklat Springs	Trapped west of Healy
0622	12/11/06	No	M	Yearling	Gray	Grant Creek	Snared east of park boundary
0701	02/14/07	No	M	Adult ~2	Gray	McKinley Slough	Missing
0702	02/14/07	No	M	Adult ~3	Gray	McKinley Slough	Recaptured, recollared
0703	02/14/07	No	F	Adult ~8	White	Hauke	Killed by wolves
0704	02/14/07	No	M	Adult ~4	Gray	Hauke	Recaptured, recollared
0402	02/27/07	Yes	F	Adult ~8	Gray	Chitsia	Died, unknown natural causes
0409	02/27/07	Yes	F	Adult ~6	White	Pinto	Trapped west of Healy
0705	03/01/07	No	F	Yearling	Light Gray	McLeod 2	Killed by wolves
0706	03/01/07	No	F	Adult ~7	Gray	McLeod 2	Died, unknown natural causes
0707	03/01/07	No	F	Adult ~2	Gray	Lone (Boot Lake)	Still being monitored
0505	03/03/07	Yes	M	Adult ~5	Gray	McKinley River	Died ,unknown natural causes
0708	03/03/07	No	F	Pup	Gray	Somber	Recaptured, recollared
0709	03/03/07	No	F	Pup	Gray	Bearpaw	Collar found near Manley
0710	03/04/07	No	F	Pup	Gray	Somber	Shot west of park boundary
0711	03/04/07	No	M	Pup	Gray	Totek Hills	Shot near lower Teklanika River
0712	03/28/07	No	F	Yearling	Black	East Fork/Savage	Trapped south of Healy
0713	03/28/07	No	M	Pup	Gray	Totek Hills	Died, unknown natural causes
0610	03/29/07	Yes	F	Adult ~6	Gray	Somber	Died, unknown natural causes
0612	03/29/07	Yes	F	Adult ~5	Blue	Castle Rocks 3	Died, unknown natural causes
0714	03/29/07	No	F	Adult ~2	Gray	Hot Slough	Killed by wolves

Table 4. (Continued). Wolf captures, Denali National Park and Preserve, 2003-2011.

WOLF	DATE	RECAP	SEX	AGE	COLOR	PACK	STATUS / FATE
0715	03/29/07	No	M	Adult ~2	Gray	Hot Slough	Died, unknown natural causes
0716	03/29/07	No	M	Adult ~5	Black	Starr Lake	Died, unknown natural causes
0403	11/27/07	Yes	F	Adult ~8	White	Turtle Hill	Died, unknown natural causes
0702	11/27/07	Yes	M	Adult ~4	Gray	McKinley Slough	Recaptured, recollared
0717	11/27/07	No	M	Adult ~5	Silver	East Fork	Recaptured, recollared
0718	11/27/07	No	F	Adult ~5	Light Gray	McKinley Slough	Died, unknown natural causes
0719	11/27/07	No	F	Adult ~2	Gray	Grant Creek	Still being monitored
0720	11/28/07	No	M	Adult ~3	Gray	McLeod 2	Trapped north of park boundary
0721	11/28/07	No	M	Yearling	Gray	Hauke	Dispersed north
0722	11/28/07	No	F	Adult ~3	Black	Kantishna River	Missing
0723	11/29/07	No	M	Adult ~3	Gray	Toklat Springs	Died, unknown causes
0724	11/29/07	No	F	Pup	Gray	Totek Hills	Trapped north of park boundary
0414	03/02/08	Yes	M	Adult ~8	Silver	Bearpaw	Died, unknown natural causes
0415	03/02/08	Yes	F	Adult ~7	Gray	Bearpaw	Still being monitored
0618	03/02/08	Yes	F	Adult ~4	Gray	East Fork	Recaptured, recollared
0801	03/02/08	No	M	Adult ~2	Gray	Kabena	Pack moved north out of area
0704	03/03/08	Yes	M	Adult ~5	Gray	Hauke	Killed by wolves after capture
0802	03/03/08	No	M	Yearling	Gray	Castle Rocks 3	Died, unknown natural causes
0803	03/03/08	No	F	Yearling	Gray	Unk/Fish Camp	Died, unknown natural causes
0609	03/04/08	Yes	F	Adult ~5	Black	Starr Lake	Missing
0804	03/04/08	No	M	Adult ~2	Gray	Starr Lake	Recaptured, recollared
0805	03/04/08	No	F	Pup	Gray	Hot Slough	Still being monitored
0806	03/04/08	No	M	Adult ~2	Gray	Castle Rocks 3	Dispersed, shot in wolf control
0807	04/02/08	No	M	Adult ~3	Gray	Savage	Not collared, last seen 12/08
0501	11/01/08	Yes	M	Adult ~2	Gray	Mount Margaret	Trapped west of Healy
0810	11/01/08	No	F	Adult ~2	Gray	Toklat Springs	Trapped north of park boundary
0811	11/01/08	No	M	Adult ~3	Gray	Grant Creek	Still being monitored
0812	11/01/08	No	F	Adult ~5	Light Gray	McKinley Slough	Still being monitored
0813	11/01/08	No	F	Adult ~7	Black	Mount Margaret	Killed by wolves
0814	11/02/08	No	M	Adult ~7	Dark Gray	Totek Hills	Dispersed North
0815	11/02/08	No	F	Yearling	Yellow gray	Hot Slough	Trapped south of Minchumina
0816	11/02/08	No	F	Adult ~3	Gray	McKinley Slough	Melted ice, drowned at capture
0817	11/03/08	No	M	Yearling	Dark Gray	Somber	Died, unknown natural causes
0818	11/03/08	No	M	Adult ~4	Gray	Tonzona	Shot on Tonzona River
0819	11/04/08	No	M	Adult ~4	Gray	Chitsia	Died, unknown natural causes
0617	02/21/09	Yes	M	Adult ~3	Black	Kantishna River	Recaptured, recollared
0722	02/21/09	Yes	F	Adult ~4	Black	Kantishna River	Died, unknown natural causes
0901	02/21/09	No	F	Yearling	Gray	Hot Slough	Died, unknown natural causes
0902	02/22/09	No	M	Adult ~2	Black	Bearpaw	Dispersed to N Fork Kuskokwim
0903	02/22/09	No	F	Yearling	Gray	Somber	Dispersed to S Fork Kuskokwim
0904	02/22/09	No	M	Adult ~2	Gray	Boot Lake	Still being monitored
0905	02/23/09	No	F	Yearling	Gray	Nenana River	Still being monitored
0906	02/23/09	No	M	Adult ~3	Black	Mount Margaret	Shot NE of Healy
0907	02/23/09	No	F	Adult ~2	Blue	Otter Lake	Died, unknown natural causes
0908	02/23/09	No	F	Adult ~2	Black	Otter Lake	Dispersed to Mucha Lake area

Table 4. (Continued). Wolf captures, Denali National Park and Preserve, 2003-2011.

WOLF	DATE	RECAP	SEX	AGE	COLOR	PACK	STATUS / FATE
0909	02/23/09	No	F	Adult ~2	Gray	Moose Creek	Killed by wolves
0910	02/23/09	No	M	Adult ~2	Gray	Moose Creek	Died, unknown natural causes
0911	02/24/09	No	M	Adult ~3	Gray	Nenana River	Killed by wolves
0702	02/19/10	Yes	M	Adult ~6	Gray	Mckinley Slough	Still being monitored
0804	02/19/10	Yes	M	Adult ~4	Gray	Starr Lake	Snared near Kantishna River
1001	02/19/10	No	F	Pup	Gray	Iron Creek	Still being monitored
1002	02/19/10	No	F	Adult ~5	Light Gray	Iron Creek	Died, unknown natural causes
1003	02/19/10	No	M	Adult ~4	Gray	Otter Lake	Shot at Telida Village
0618	11/27/10	Yes	F	Adult ~7	Gray	East Fork	Still being monitored
0717	11/27/10	Yes	M	Adult ~8	Silver	East Fork	Snared on Toklat River
1004	11/27/10	No	M	Yearling	Gray	Grant Creek	Still being monitored
1005	11/27/10	No	M	Pup	Gray	Unknown	Trapped in Dry Creek
1006	11/29/10	No	F	Pup	Black	Bearpaw	Still being monitored
1007	12/01/10	No	M	Pup	Dark Gray	Nenana River	Died, unknown natural causes
1008	12/01/10	No	F	Yearling	Black	Hot Slough	Still being monitored
1009	12/01/10	No	M	Yearling	Gray	Iron Creek	Still being monitored
1101	03/08/11	No	F	Yearling	Light Gray	East Fork	Still being monitored
1102	03/08/11	No	M	Pup	Black	East Fork	Still being monitored
0811	03/10/11	Yes	M	Adult ~5	Gray	Grant Creek	Still being monitored
1103	03/10/11	No	F	Yearling	Gray	Grant Creek	Still being monitored
1105	03/10/11	No	M	Yearling	Gray	Nenana River	Still being monitored
0617	03/11/11	Yes	M	Adult ~5	Black	Somber	Still being monitored
0708	03/11/11	Yes	F	Adult ~4	Gray	Somber	Still being monitored
1106	03/11/11	No	F	Yearling	Gray	Mckinley Slough	Still being monitored
1107	03/11/11	No	M	Pup	Gray	Mckinley Slough	Still being monitored
1108	03/11/11	No	M	Adult ~3	Gray	Iron Creek	Still being monitored
1109	03/11/11	No	M	Adult ~2	Black	Somber	Still being monitored

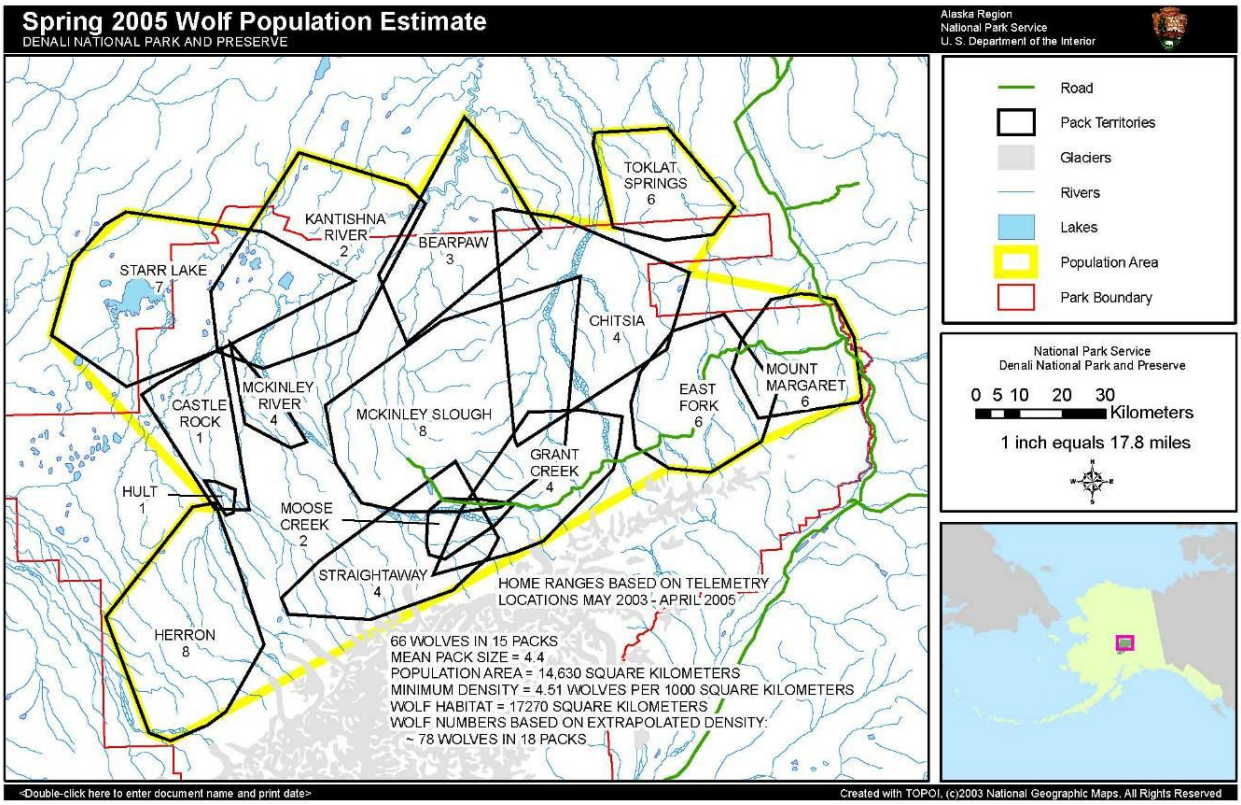

Figure 1. Wolf pack territories and population estimate for Denali National Park and Preserve, 2005.

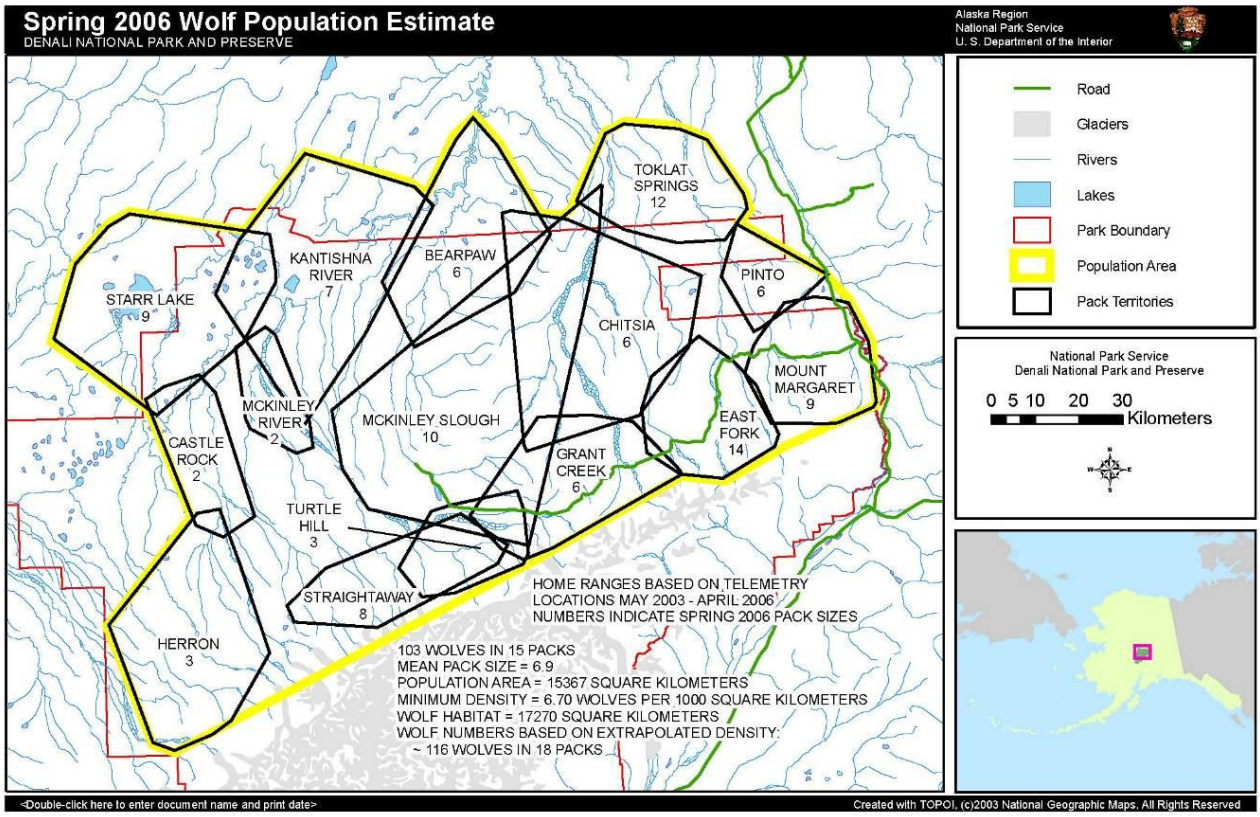

Figure 2. Wolf pack territories and population estimate for Denali National Park and Preserve, 2006.

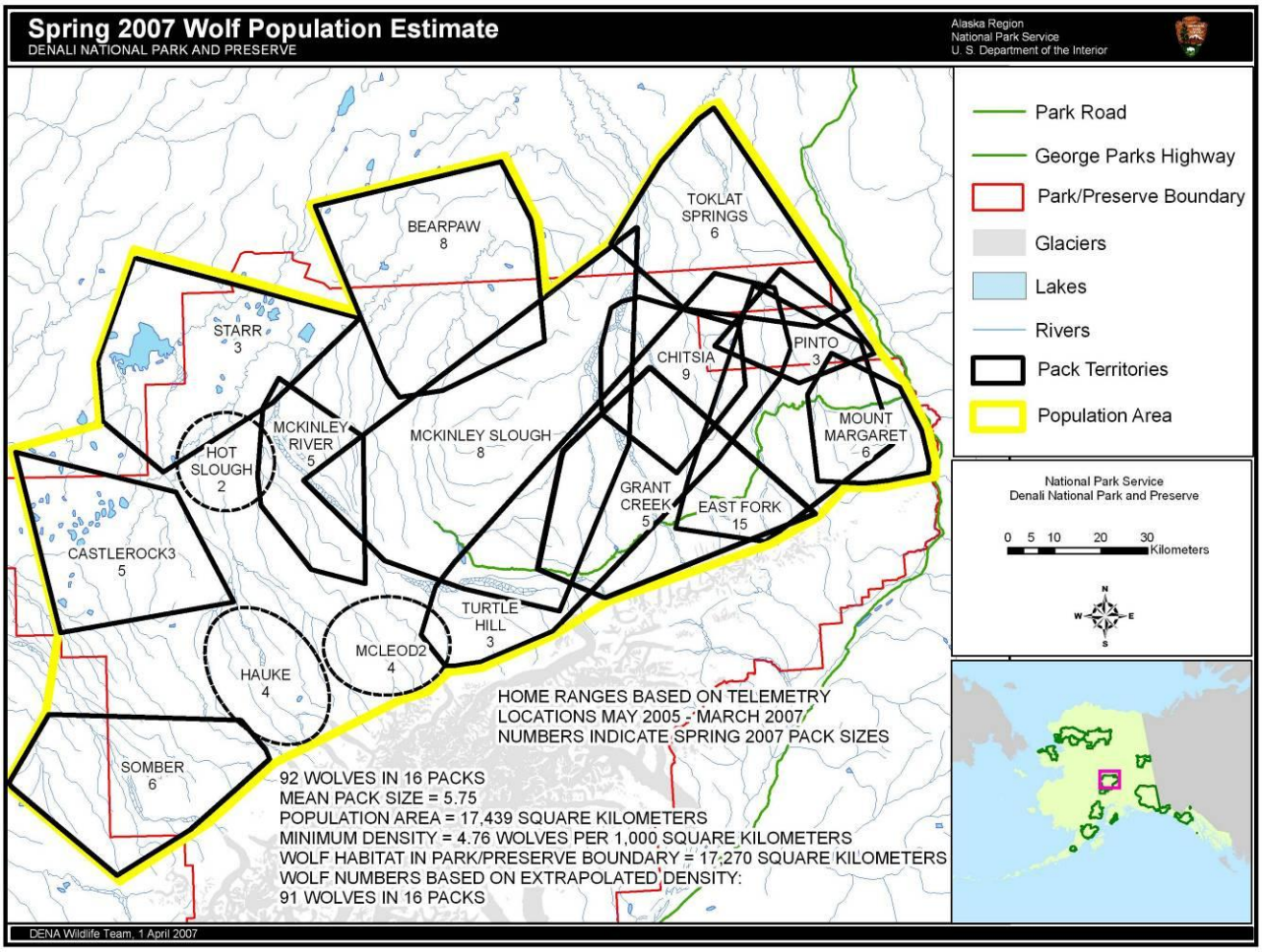

Figure 3. Wolf pack territories and population estimate for Denali National Park and Preserve, 2007

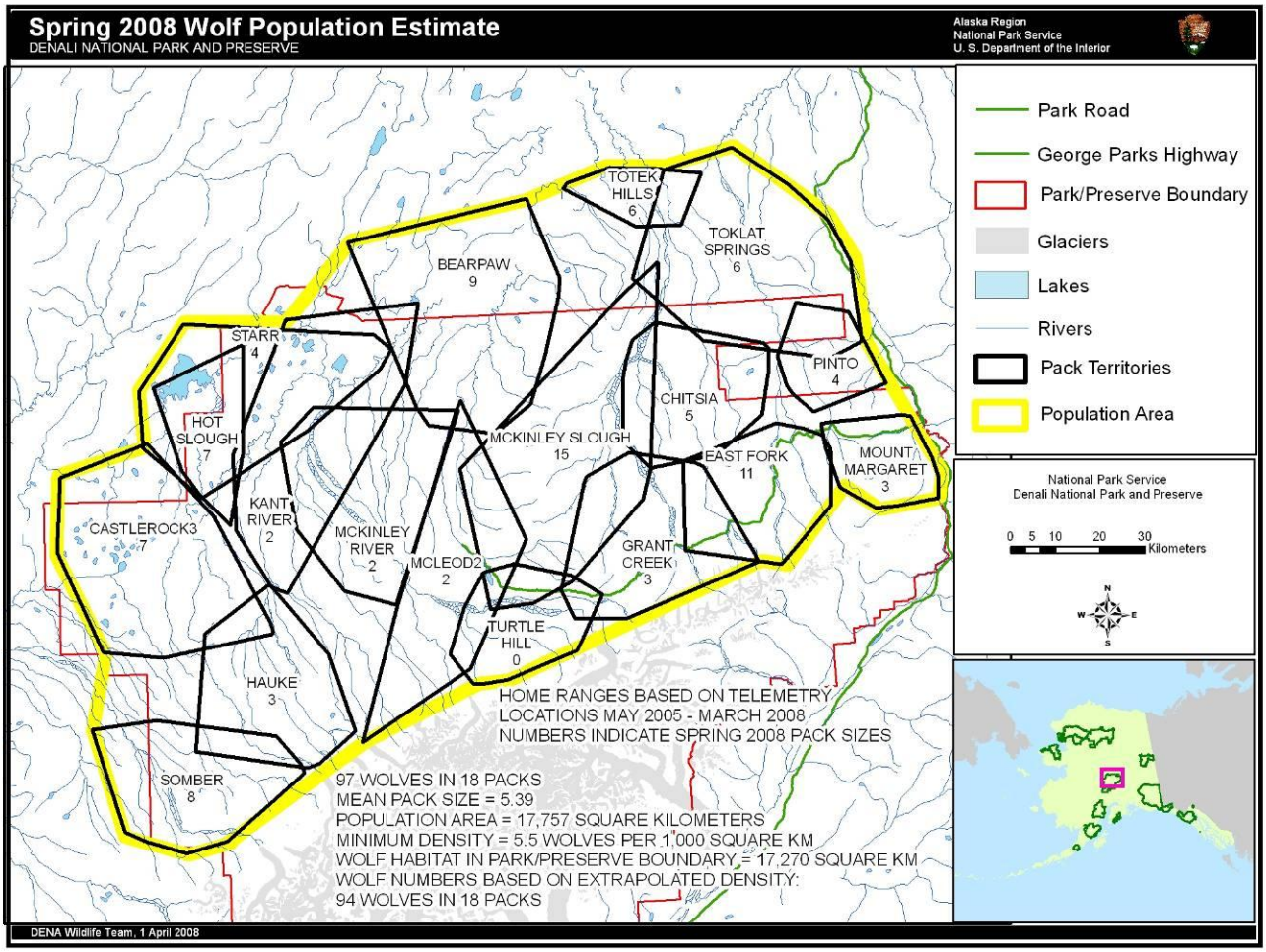

Figure 4. Wolf pack territories and population estimate for Denali National Park and Preserve, 2008.

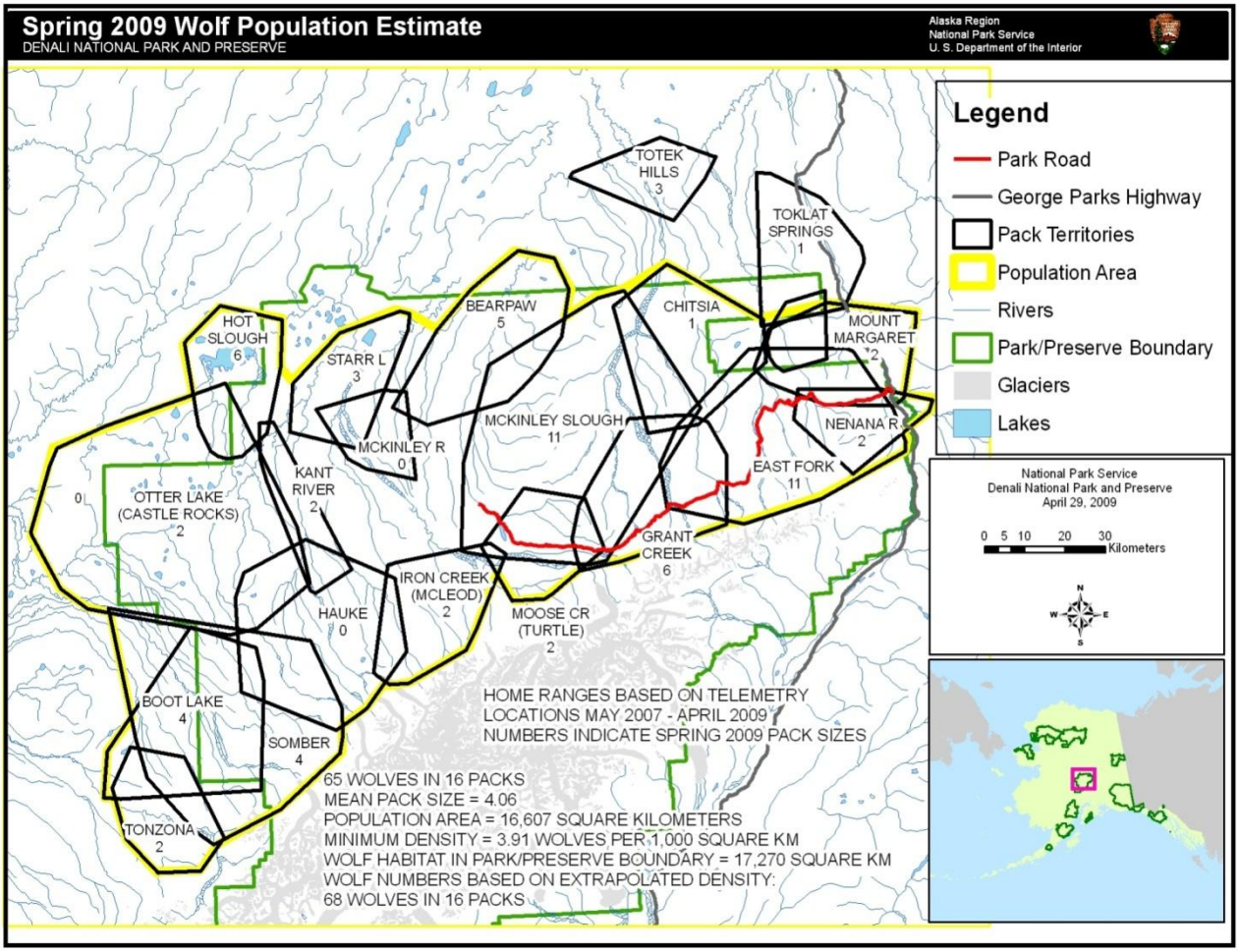

Figure 5. Wolf pack territories and population estimate for Denali National Park and Preserve, 2009.

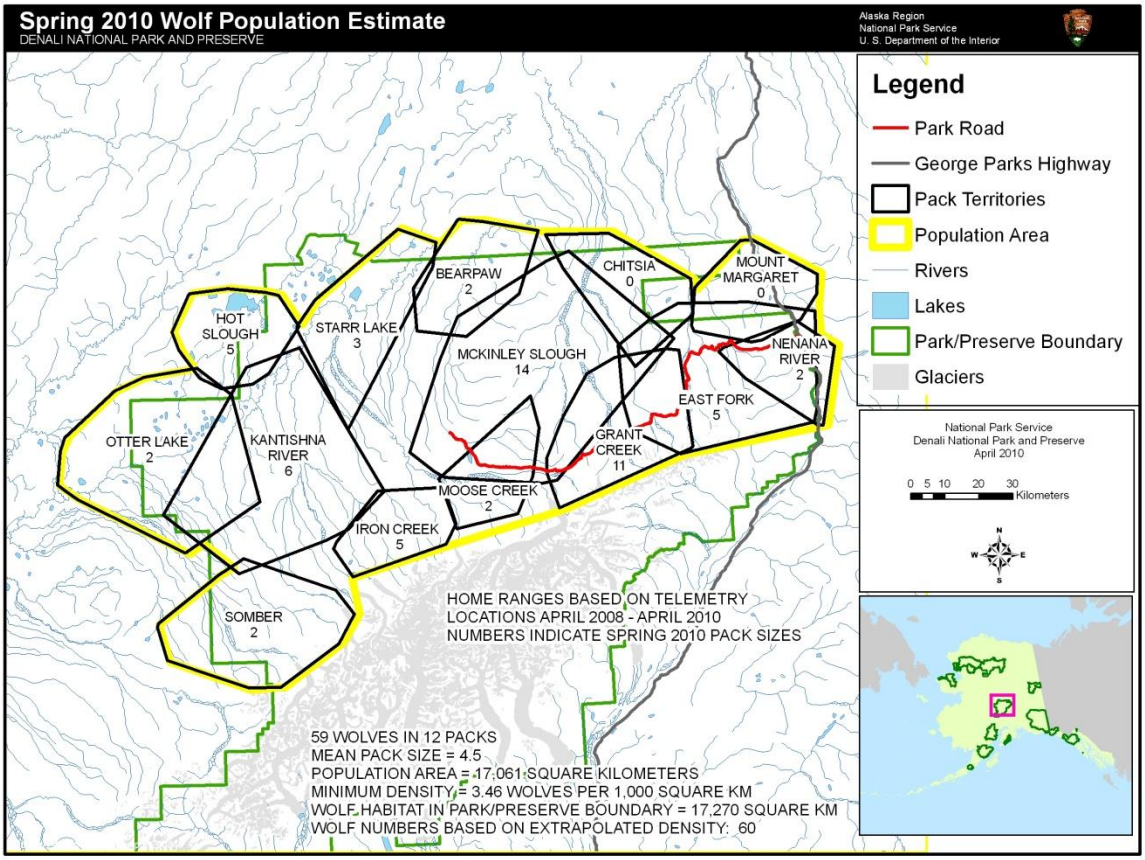

Figure 6. Wolf pack territories and population estimate for Denali National Park and Preserve, 2010.

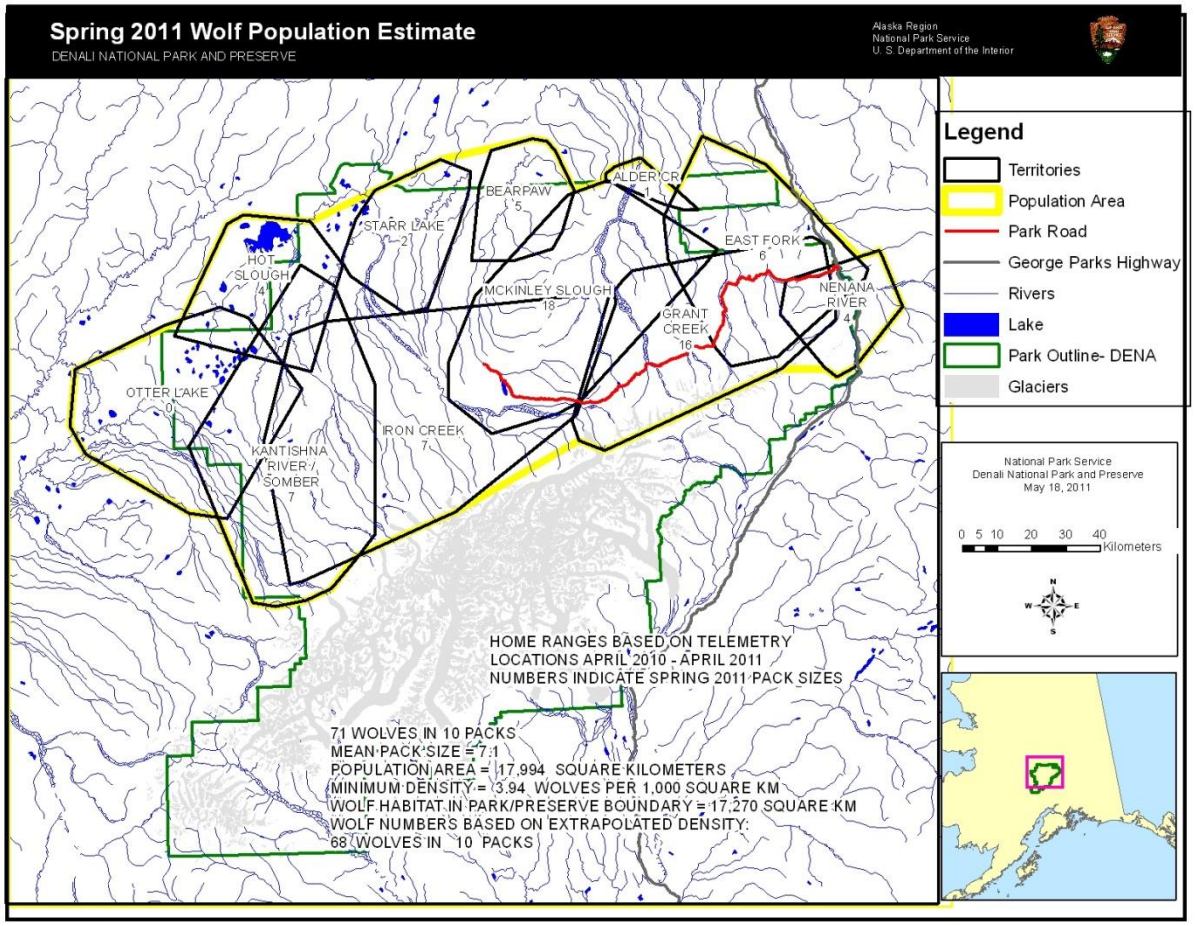

Figure 7. Wolf pack territories and population estimate for Denali National Park and Preserve, 2011.

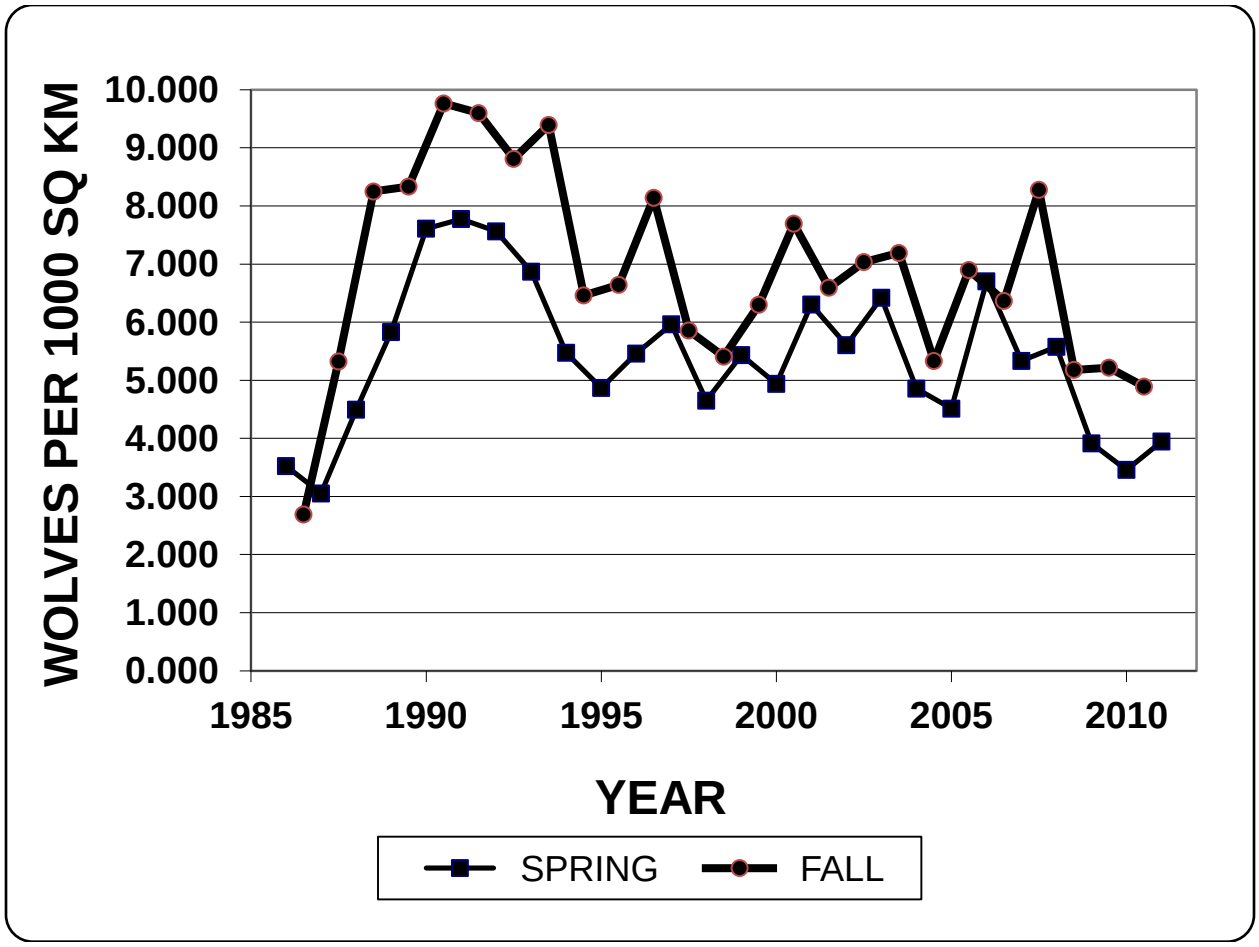

Figure 8. Wolf density estimates, Denali National Park and Preserve, 1986-2011.

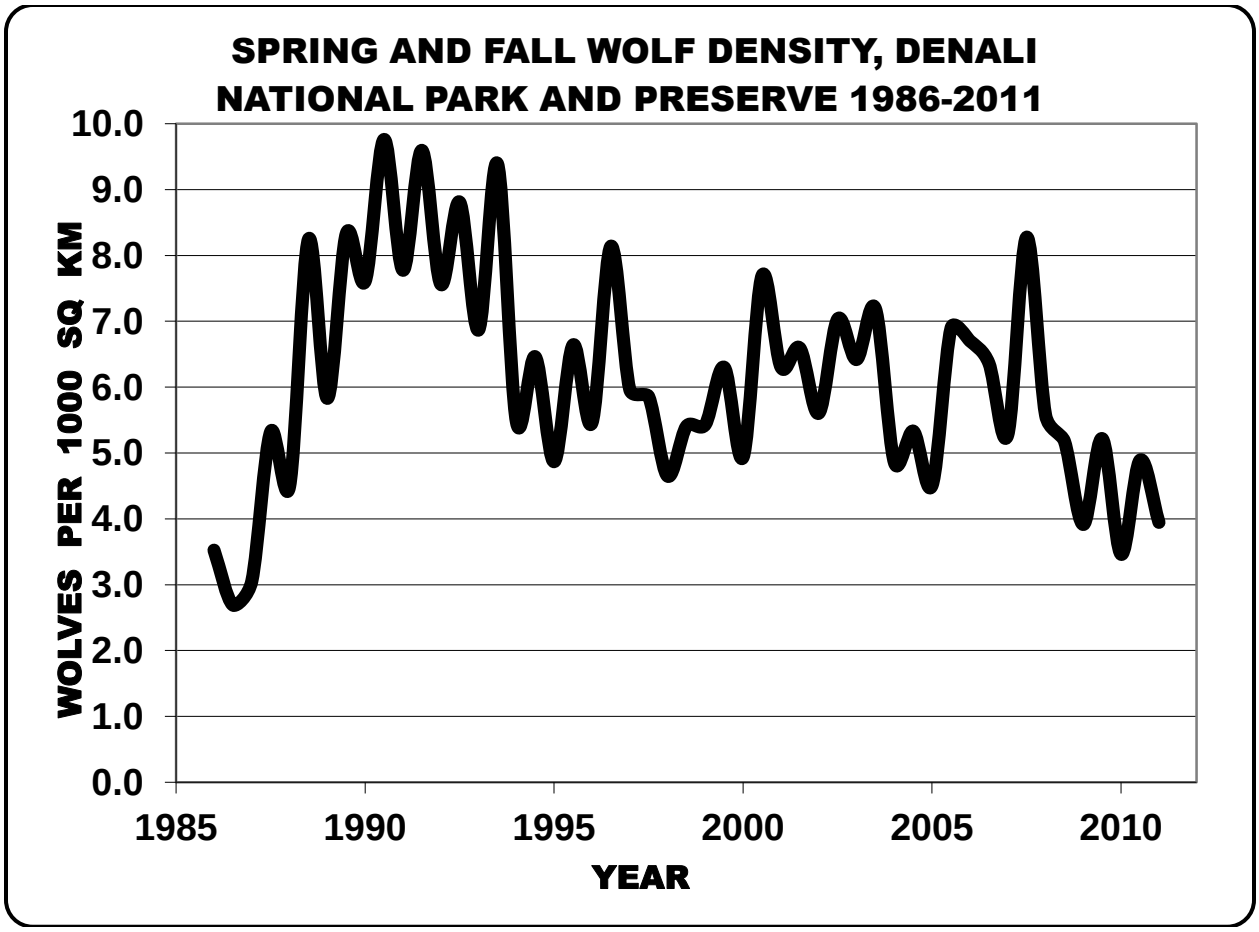

Figure 9. Wolf density estimates, Denali National Park and Preserve, 1986-2011, spring and fall estimates on the same plot.

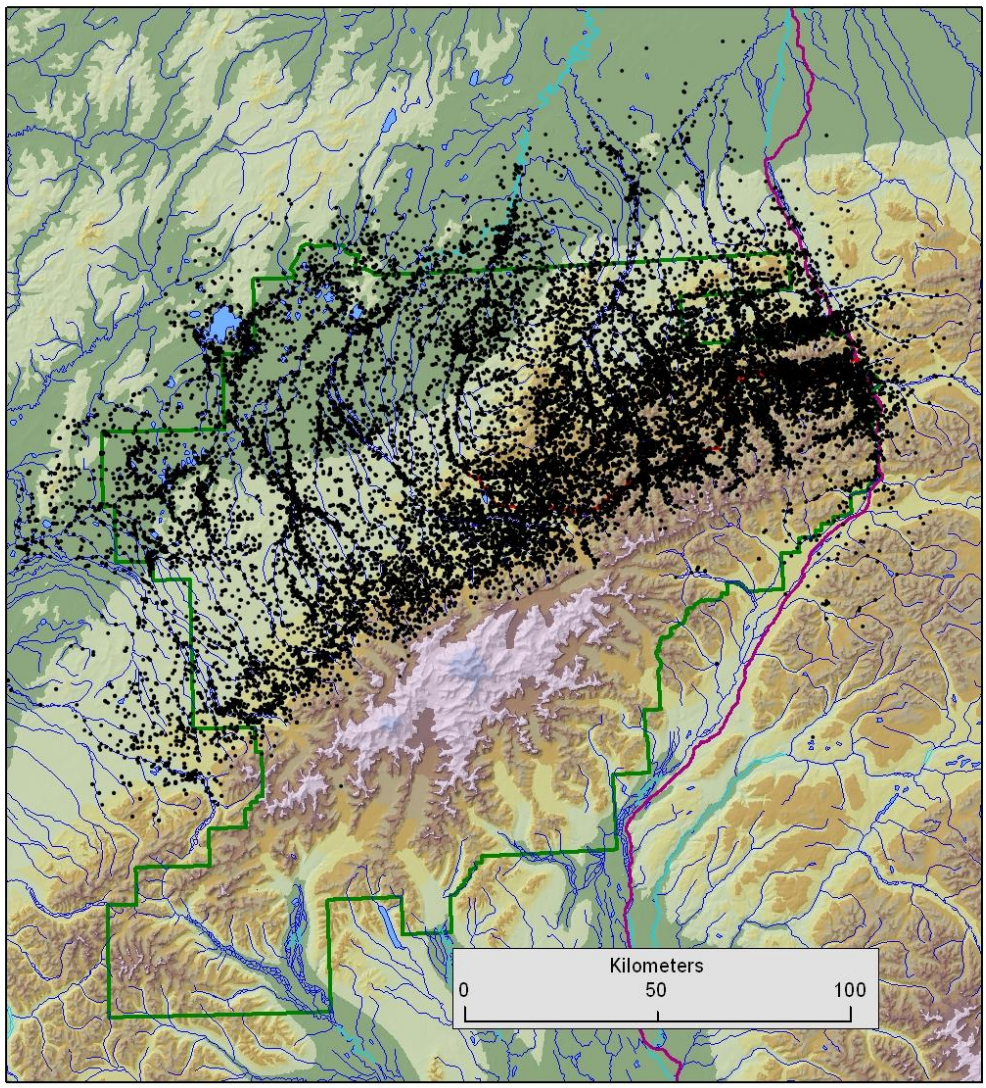

Figure 10. Locations of VHF- and GPS-collared wolves, 1986-2011.

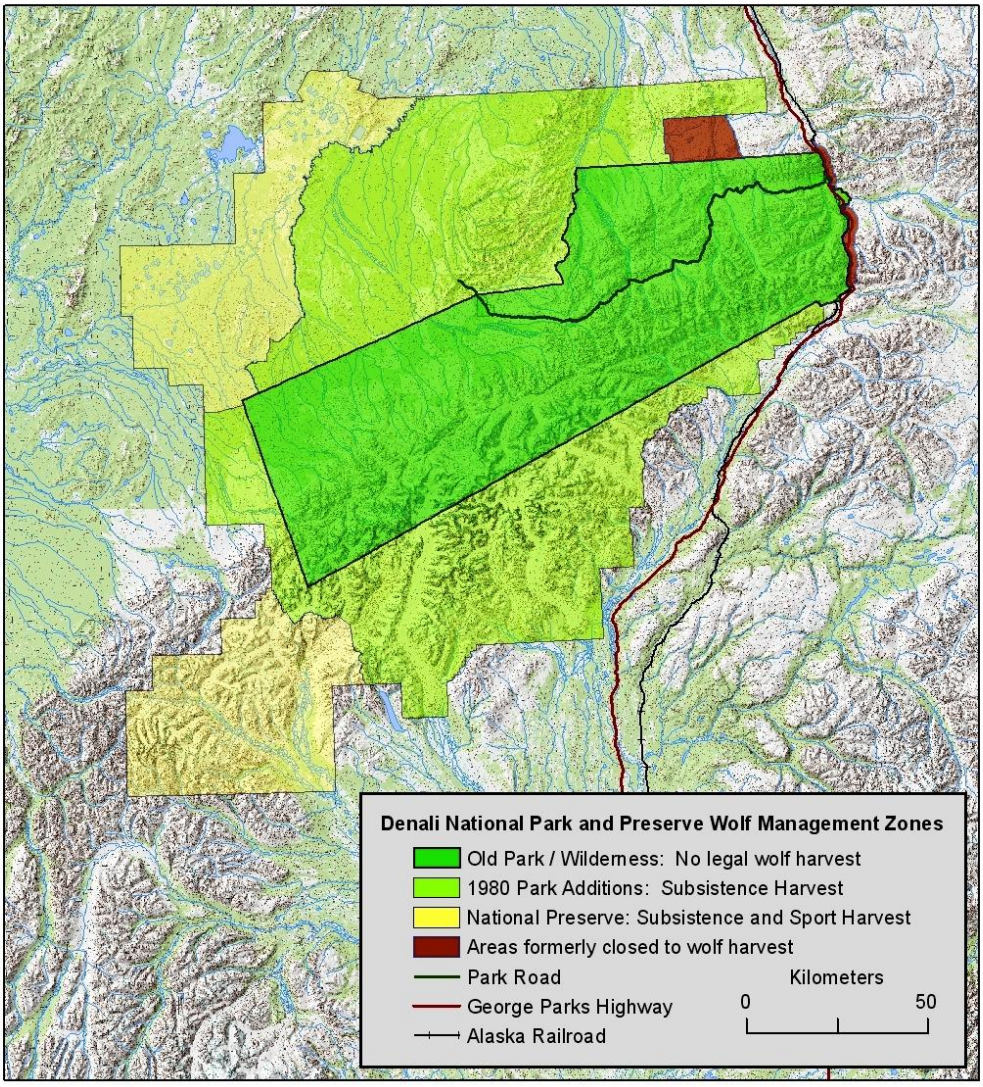

Figure 11. Denali National Park and Preserve, showing areas of differing wolf management.